Pre-College Education Project

Fish Banks Policy Analysis Exercise
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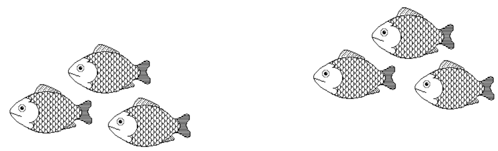


Name ________________________

The year is 1970.

You are a manager in the national fish and wildlife service. You are charged with the responsibility of making policy suggestions regarding the management of a fishery surrounding your national borders. Fishing is an important source of economic income for your country so your decisions must insure the healthy maintenance of the fish population and fishing industry.

Luckily, you have retained some expensive consultants from MIT (paid with government money, of course). The consultants have built a model of the fish population and fishing industry in your nation. They claim that you can use the model to test the impact of different regulatory policies on the fish population and fishing economy. A diagram of the model is shown below in Figure 1.

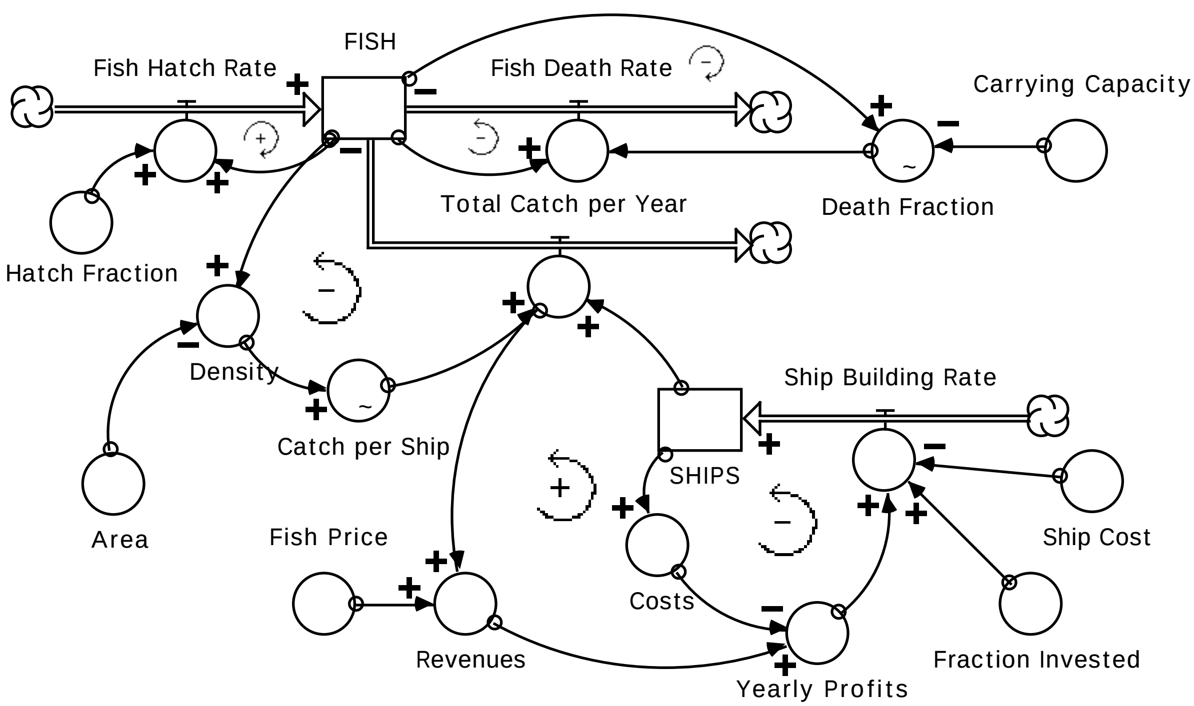


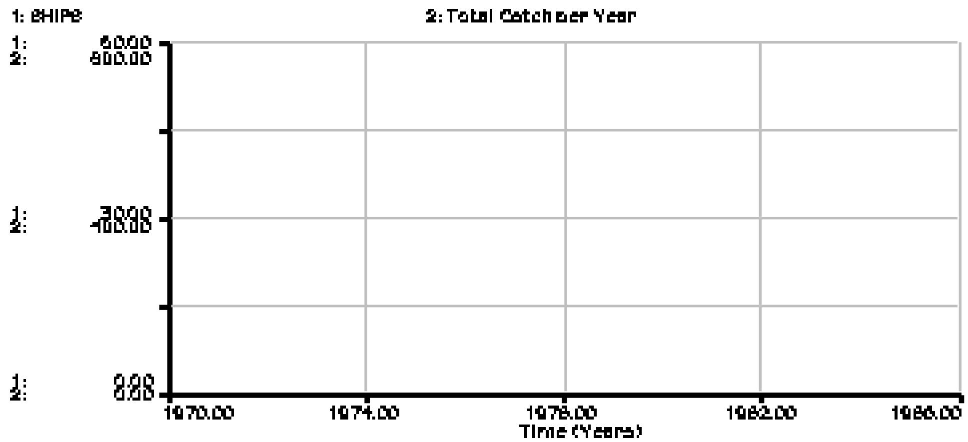
Figure 1: STELLA Diagram of Fish Banks Model

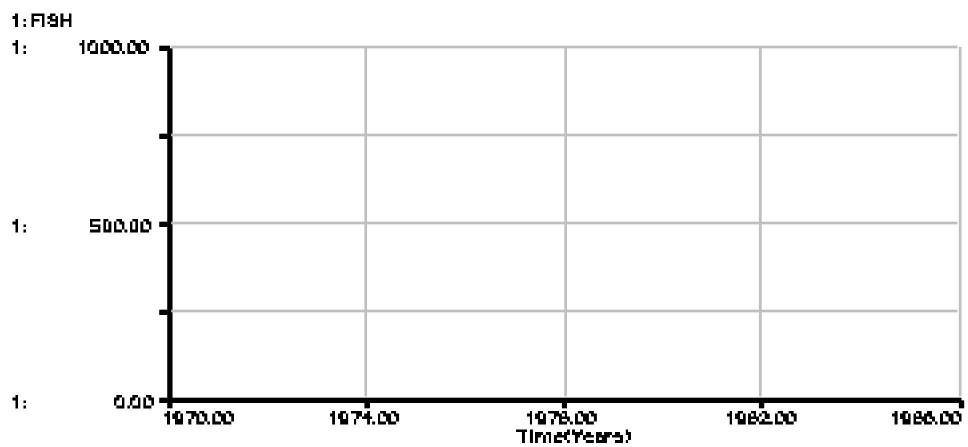
YOUR TASKS:

1. The model is currently set up to simulate the regulatory situation present within the national fishing industry as of 1970 (no regulation). To simulate the system:

- **Select Graph Pad from the Windows Menu**
- **Select Run from the Run Menu**

Observe the behavior of the number of ships, catch per year, fish population, and total accumulated profits on the different pages of the graph pad. The pages may be changed by clicking on the page numbers on the top right of the graph pad window. Sketch the graphs of ships, catch per year, and fish population on the axes below.

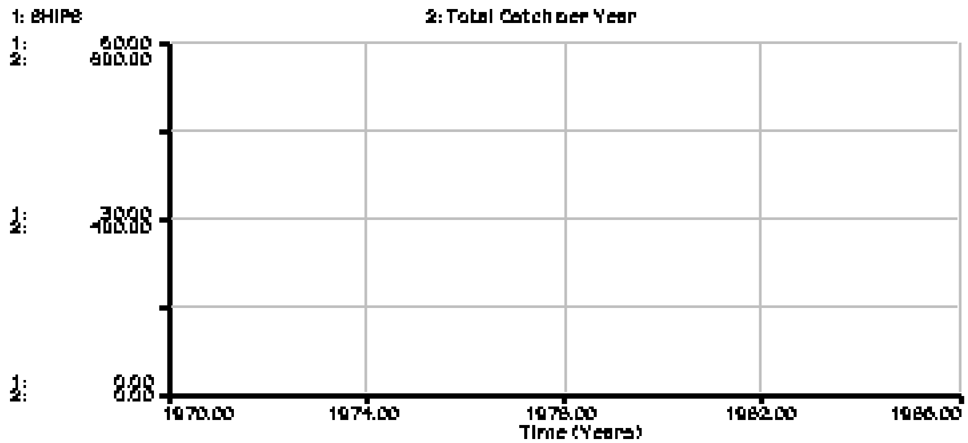


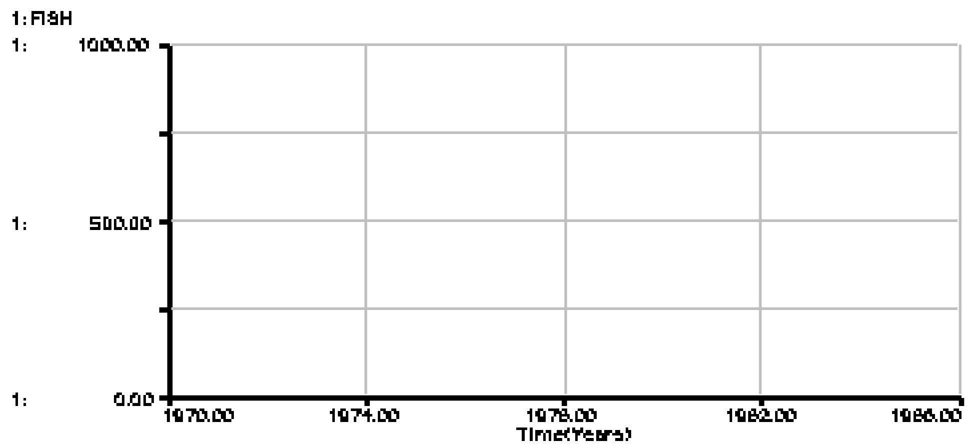


Explain in a few sentences why the system generated the exhibited behavior. Try to tell the story of what happened in the Fish Banks simulation by making reference to the feedback loops describing the system.

2. Clearly, leaving the present system undisturbed is an unacceptable situation. The fish population is decimated, the fishing industry dies, and you lose your job.

One regulatory policy which might help avoid this situation is to levy a large tax on new ships (say $200 per ship), thereby raising the price and curtailing purchases. Sketch on the axes below the effect you believe that this policy will have on the number of ships, total catch per year, and fish population.





Try running this policy by changing the ship cost from $300 to $500.

- **Double-click on the converter labeled "Ship Cost"**
- **Type "500"**
- **Click the OK Button**

Once you have changed the ship cost, simulate the system:

- **Select Graph Pad from the Windows Menu**
- **Select Run from the Run Menu**

Using either a dashed line or different colored pen, sketch on these same axes: the computer simulated graphs of ships, total catch per year, and fish population.

Was this policy successful? How does the behavior generated in this simulation compare with the previous behavior? Explain the differences in behavior.

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Vary the amount of the tax and re-simulate to observe the effects on behavior. What behavior is exhibited if the tax is too high?

3. It is clear that a tax on ships seems to do nothing more than delay the destruction of the fish population. Another possible policy alternative is to keep building ships until there is a noticeable problem with the fish population. Since the only feedback signal from the fish population that fishermen receive is from the fish catch, the policy could make building ships illegal once the catch per ship decreases to an unacceptable rate.
To implement this policy first change the ship cost back to 300 dollars per ship.

- **Double-click on the converter labeled "Ship Cost"**
- **Type "300"**
- **Click the OK Button**

Next insert the feedback from catch per ship to ship building rate. During good fishing, the average ship will catch 25 fish per year. See what happens when the ship building is limited after the catch drops below 22 fish per year.

- **Draw a causal connection from Catch per Ship to Ship Building Rate**
- **Insert the following equation:**

```
if Catch_per_Ship>22 then Yearly_Profits*Fraction_Invested/Ship_Cost else 0
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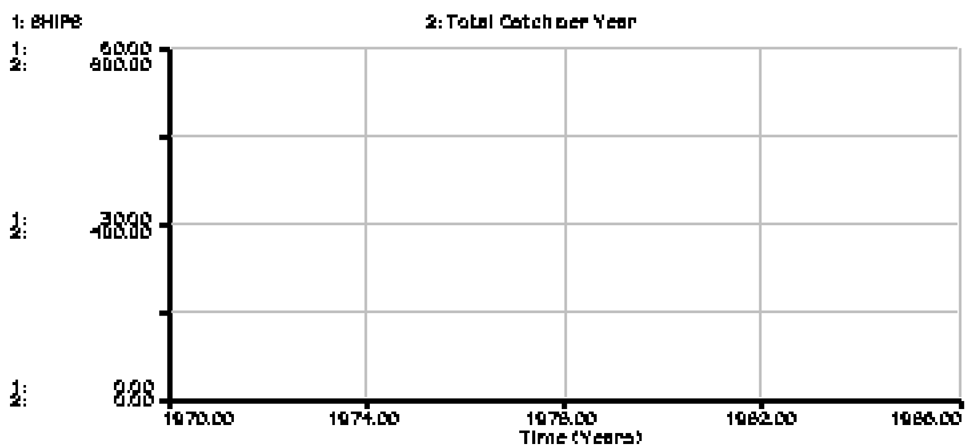
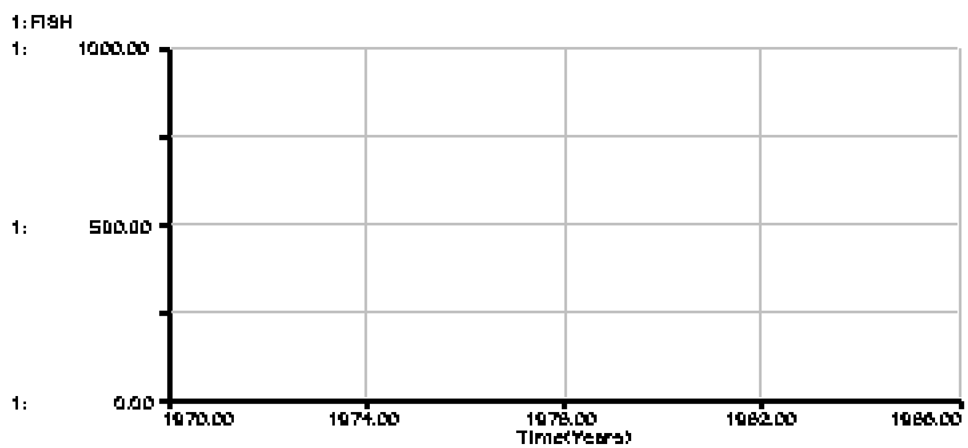
This equation says that if the catch per ship is greater than 22 fish per year then purchase the normal number of ship (Profits*Fraction Invested / Ship Cost). However, if the catch per ship falls below 22, then build 0 ships.

Graph on the axes below the effect you believe this regulation will have on the system.





Run the model and sketch the computer simulated behavior on the axes above using either dashed lines or a different colored pen.

Were your predictions correct? How does the behavior generated based on the new regulation differ from a system with no regulation? Explain any differences or lack of differences.

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Was this policy successful? If not, try increasing the threshold on Catch per Ship from 22 to a higher number. At what number does the system produce a stable fish population?

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What factors not present within the model might affect the catch per ship?

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How easy do you think it will be for the government to collect data on the catch per ship? What problems might be encountered?

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Write down a plan outlining how you would collect the data in order to decide when to limit the ship building rate.

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Do you get the impression that fishing systems tend to give a great deal of warning before a catastrophe or do you feel these catastrophes come on more suddenly? Is the catch per ship an accurate indication of the fish population? Explain why by referring to the graph of Fish Catch per Ship and its relationship to fishing technology.

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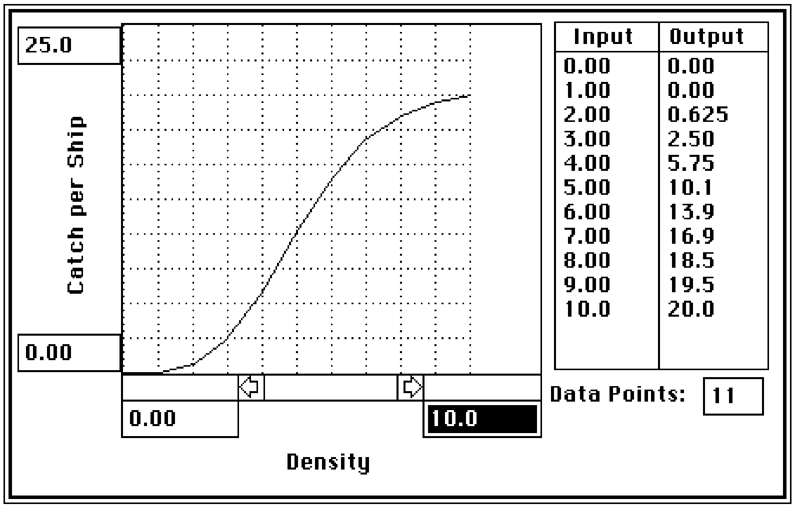
4. Another policy alternative is to make certain fishing technologies illegal making it more difficult for ships to catch fish. Fewer fish caught means that the fish population has a better chance for survival. To implement this policy, first return the model to its original state:

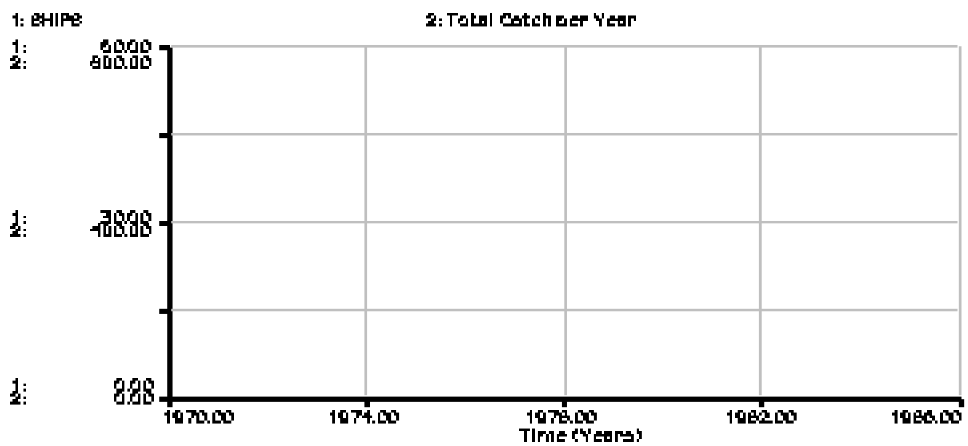
- **Select "Revert to Saved" under the file menu**

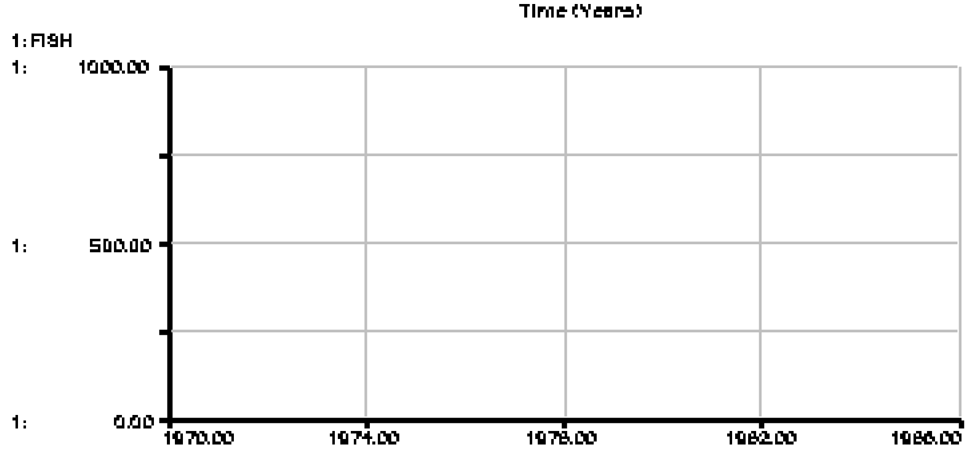
Next, change the graph defining catch per ship to model low fishing technology.

- **Double-click on the converter labeled catch per ship**
- **Change the graph so that it matches the one found below**



Once again try to predict how this policy will affect the number of ships, catch per year, and fish population by sketching on the axes below.





Run the model and sketch the computer simulated behavior on the previous axes using either dashed lines or a different colored pen.

How does this policy alternative seem to work? Were your predictions correct? If not, why were they incorrect? If you would like to run the time axis out further:

- **Select Simulation Time under the run menu and change the final time value.**

What are your accumulated profits here as compared to previous simulations? Explain why the fishermen's accumulated profits are greater or lesser under this regulation.

Comment on the likelihood of being able to implement regulation of fishing technology. What groups would be opposed to or in support of such regulation? Do you think that your job would be in jeopardy if you proposed such a regulation?

5. Another policy might be to force all boats over a certain age have to be dry docked for safety reasons. This would create an outflow from the stock of ships. To implement this policy, first return the model to its original state:

- **Select "Revert to Saved" under the file menu**

To model the policy:

- **Select the Flow icon on the upper left portion of the STELLA Diagram Window**
- **Place the Flow icon on top of the stock labeled SHIPS**
- **Hold the mouse button down and drag the mouse an inch to the left**
- **Release the Mouse Button**
- **Type "Ship Scrapping Rate"**

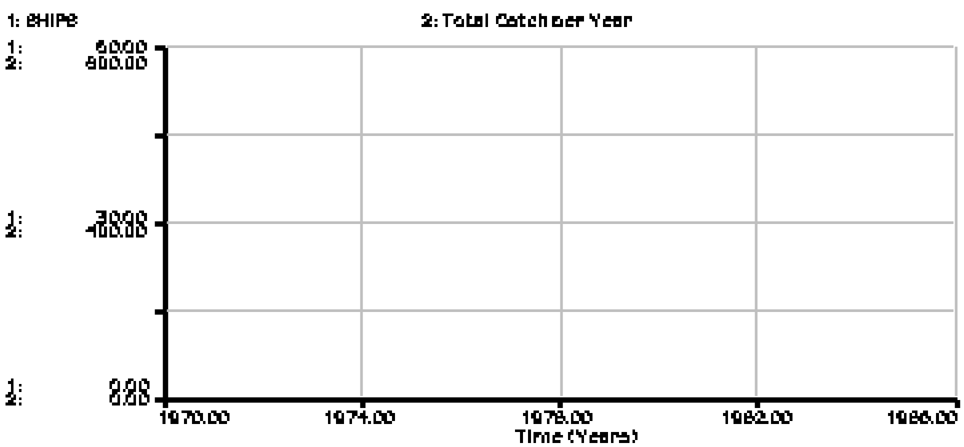
To define the flow, it is necessary to have a converter specifying the maximum age of ships:

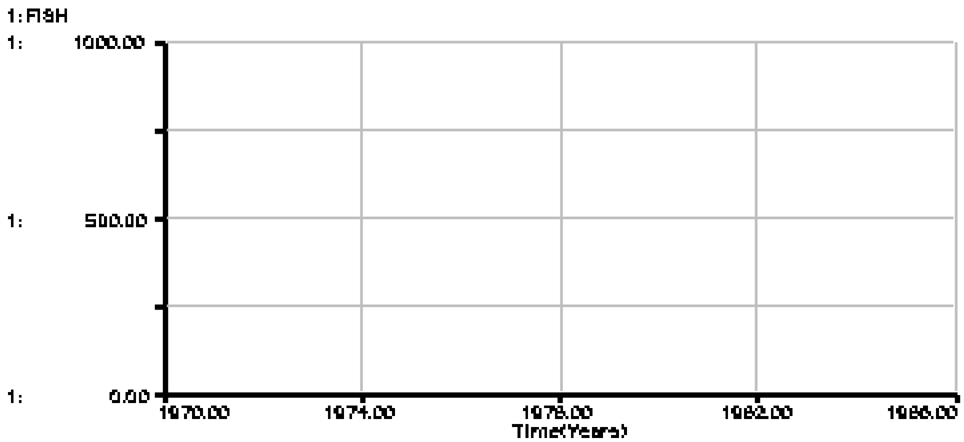
- **Select the Converter icon on the upper left portion of the STELLA Diagram Window**
- **Place the Converter icon just underneath the Ship Scrapping Rate flow**
- **Click the Mouse Button**
- **Type "Maximum Ship Lifetime"**
- **Double-click on Maximum Ship Lifetime and give it a value of 12 years**

All that remains is to determine the equation for the Ship Scrapping Rate. Assuming that the age of the ships is evenly distributed from young to old, about one-twelth of the ships are scrapped each year due to old age. The equation defining ship scrapping rate is therefore the number of ships divided by the maximum age. To model this:

Draw a converter from SHIPS to Ship Scrapping Rate
Draw a converter from Maximum Ship Lifetime to Ship Scrapping Rate
Double-click on Ship Scrapping Rate
Define Ship Scrapping Rate to be SHIPS/Maximum Ship Lifetime

Once again try to predict how this policy will affect the number of ships, catch per year, and fish population by sketching on the axes below.





Run the model and sketch the computer simulated behavior on the previous axes using either dashed lines or a different colored pen.

Were your predictions correct? How does the behavior generated based on the new regulation differ from a system with no regulation? Try to tell the story of the differences between the two simulations by making reference to the feedback loops describing the system.

Continue to simulate the model with different maximum ship lifetimes. What happens if the maximum ship lifetime is made too short? Why?

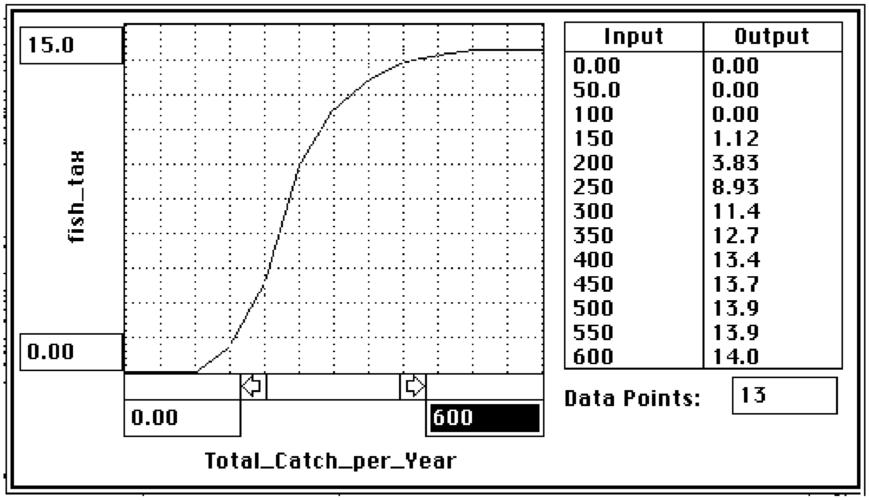
Do you think a regulatory policy such as this would be fair to the fishermen? Why?

6. Suppose that we design an environmental tax which will tax the fishermen on a per fish basis based on the total number of fish which are caught each year. To implement this policy, first return the model to its original state:

- **Select "Revert to Saved" under the file menu**

To model the policy:

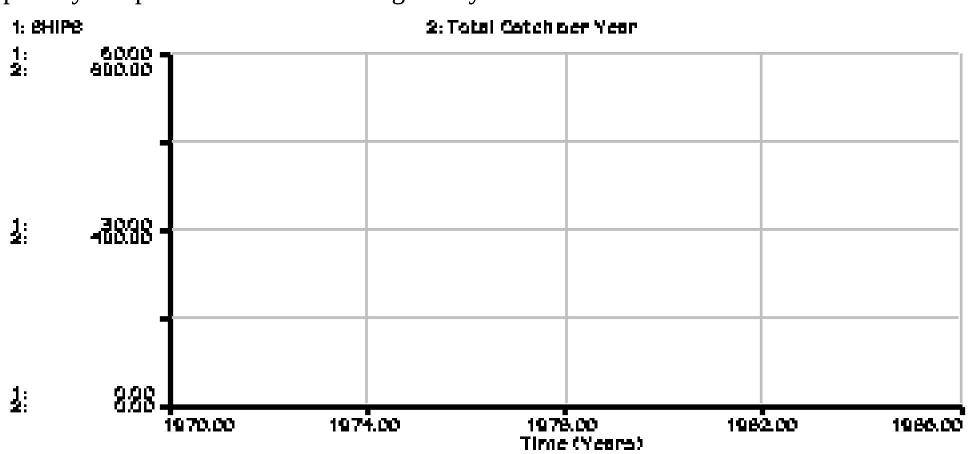
- **Create a new converter called Fish Tax**
- **Draw a causal connection from Total Catch per Year to Fish Tax**
- **Define Fish Tax as the table function shown below**

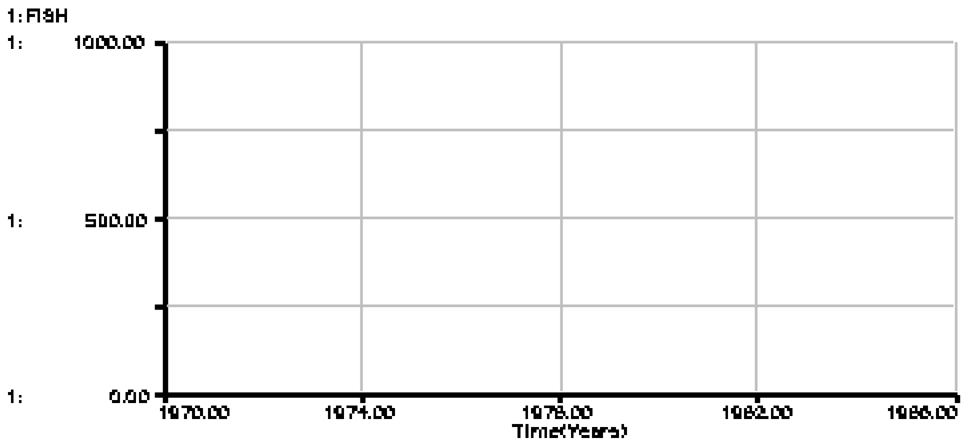


Input	Output
0.00	0.00
50.0	0.00
100	0.00
150	1.12
200	3.83
250	8.93
300	11.4
350	12.7
400	13.4
450	13.7
500	13.9
550	13.9
600	14.0

- **Draw a causal connection from Fish Tax to Costs**
- **Define Costs as "SHIPS * 200 + Fish Tax"**

Again, place your predictions concerning the system behavior on the axes below.





Run the model and sketch the computer simulated behavior on the previous axes using either dashed lines or a different colored pen.

Were your predictions correct? How and why does such a policy affect the fishermen's profits? Is this an acceptable policy solution?

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The behavior generated using this regulatory policy is most similar to which previous policy test? Why?

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7. Can you come up with any policies which have not been tried above? If so, list them below and attempt to model them if you have time.

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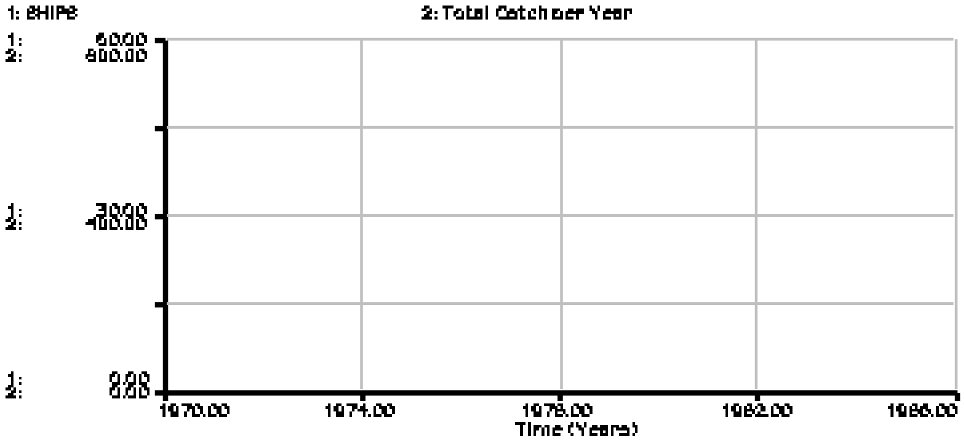
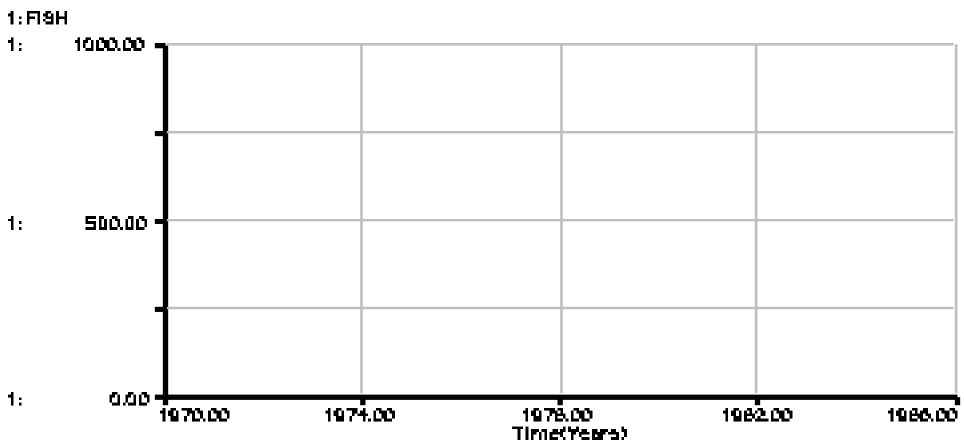
8. Devise your own regulatory plan incorporating any or all of the regulatory policies tested above. Implement your plan on the model, and record the results on the graphs below.





What final policy plan would you recommend to the Wildlife and Fisheries Service? Clearly state the goals you are trying to meet and describe what an effective policy should accomplish? Justify your choice, and explain how it will work. Give your predictions regarding how your policy plan will be accepted by fishermen, politicians, and the public? Describe any possible difficulties associated with the implementation of your plan.